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(54) Thin-film electroluminescent element.

(57) The development of a dielectric thin-film which is high (140 MV/cm or above) in product of dielectric constant ϵ , and dielectric breakdown field strength E_b is essential for realizing an EL element which can operate stably at a low voltage. Such dielectric film is also required which can withstand heat treatments at high temperatures above 500°C and is proof against clouding and in which the electrical breakdown caused by a minute fault produced in the process of film formation is self-healed. A film material which satisfies all of these requirements could be obtained from a TiO_2 -BaO based composition by partially substituting the position of Ti with Sn, Zr or Hf and also partially substituting the position of Ba with Ca or Mg. By using these dielectric films, it is possible to obtain a low-voltage drive thin-film electroluminescent element which are high in production yield and reliability.

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(54) Thin-film electroluminescent element.

(57) The development of a dielectric thin-film which is high (140 MV/cm or above) in product of dielectric constant ϵ_r and dielectric breakdown field strength E_{10} is essential for realizing an EL element which can operate stably at a low voltage. Such dielectric film is also required which can withstand heat treatments at high temperatures above 500°C and is proof against clouding and in which the electrical breakdown caused by a minute fault produced in the process of film formation is self-healed. A film material which satisfies all of these requirements could be obtained from a TiO_2 -BaO based composition by partially substituting the position of Ti with Sn, Zr or Hf and also partially substituting the position of Ba with Ca or Mg. By using these dielectric films, it is possible to obtain a low-voltage drive thin-film electroluminescent element which are high in production yield and reliability.

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THIN-FILM ELECTROLUMINESCENT ELEMENT

1 TECHNICAL FIELD

The present invention relates ~~to an electro-~~ luminescent element, and more particularly to a thin-film electroluminescent element which is actuated in an AC
5 field. Such electroluminescent element has specific characteristics that enable the realization of plate displays, and it is especially suited for adaptation to character and graphic terminal displays for personal
10 computers, etc., therefor can be widely applied to the field of office automation systems.

BACKGROUND ART

Generally, electroluminescent element (hereinafter abbreviated as EL element) which emits light upon application of an AC field has a structure in which a
15 filmy layer of a dielectric is provided on one side or both sides of a thin layer of an electroluminescent phosphor and these laminate layers are sandwiched by two electrode layers. The phosphor layer used in such element is basically composed of such material as ZnS, ZnSe or
20 ZnF₂ doped Mn or a rare-earth fluoride as luminescent center in said base material. ZnS phosphor element using Mn as luminescent center is capable of providing a luminance of up to about 3,500-5,000 Cd/m² by the application of an AC voltage with a frequency of 5 kHz.

1 Typical examples of dielectric material used in
said element are Y_2O_3 , SiO_2 , Si_3N_4 , Al_2O_3 and Ta_2O_5 . The
thickness of ZnS layer is about 5,000 to 7,000 Å and that
of dielectric layer is about 4,000 to 8,000 Å.

5 In the case of AC drive, the voltage applied
to the element is divided to ZnS layer and dielectric
layer. Since EL element is structurally equivalent to a
series connection of two capacitors, there holds the
relation of $\epsilon_i V_i / t_i = \epsilon_z V_z / t_z$ (ϵ : dielectric constant;
10 V: voltage applied; t: thickness; suffix i: indicating
dielectric; suffix z: indicating ZnS), and thus each
divided voltage is reversely proportional to the di-
electric constant if $t_i = t_z$. In said dielectrics such
as Y_2O_3 , ϵ_i is about 4 to 25 and ϵ_z of ZnS is about 9, so
15 that only about 30 to 70% of the whole applied voltage is
given to the ZnS layer. In such elements, therefore, a
high voltage above 200 V must be applied by a pulse
drive of several kHz. Such high voltage gives a great
deal of load to the drive circuit and necessitates a
20 specific high-voltage withstanding drive IC, which leads
to the increased production cost of the element.

A discussion is here made on what characteristics
the dielectric layer is required to have for reducing the
drive voltage. From the above-shown relation concerning
25 voltage division, it is noted that the ϵ_i to t_i ratio
(ϵ_i / t_i) must be great. After the start of emission of
light, any increment of applied voltage is given to the
dielectric layer, so that V_{ib} (dielectric breakdown voltage

1 of the dielectric layer) must be also high for giving an excellent dielectric film. Therefore, the figure of merit γ of the dielectric layer is defined as follows:

$$\gamma = \epsilon_i V_{ib} / t_i = \epsilon_i E_{ib}$$

(E_{ib} : dielectric breakdown field strength
of the dielectric film)

As noted from the above equation, γ is proportional to the electric charge accumulated per unit area of the dielectric layer when dielectric breakdown occurs. The greater the value of γ , the more stably can be conducted the low-voltage drive. This can be attributed to the following fact. In two EL elements which are same in phosphor layer thickness and dielectric layer thickness but different in properties of dielectric layer (for example, the dielectric layer in one of the elements having the properties of $\epsilon_i = 100$, $E_{ib} = 1 \times 10^6$ V/cm and $\gamma = 100 \times 10^6$ V/cm while the dielectric layer in another element having the properties of $\epsilon_i = 50$, $E_{ib} = 3 \times 10^6$ V/cm and $\gamma = 150 \times 10^6$ V/cm), naturally the former element can start to emit at a lower voltage than the latter element as they are same in thickness of dielectric layer. However, in the latter element where $\epsilon_i = 50$ and $E_{ib} = 3 \times 10^6$ V/cm, if it is equalized to the former element in breakdown strength, its layer thickness can be reduced to 1/3. Consequently, its dielectric capacity is

1 trebled, boosting ϵ_1 to 150. Therefore, a greater
figure of merit allows the production of an element
which emits light at a lower voltage, regardless of ϵ_1 .
The greater the value of γ , the better, but practically,
5 it is desirable that γ is about 10 times the value of
 14×10^6 V/cm that is obtained by substituting $\epsilon_z = 9$
and $E_{zb} = 1.6 \times 10^6$ V/cm of ZnS for ϵ_1 and E_{ib} in the
above-shown formula and used as a standard value for low-
voltage luminescence.

10 The conventional dielectric films are small in
their figure of merit, which is about 50×10^6 V/cm in
the case of Y_2O_3 , about 30×10^6 V/cm in the case of
 Al_2O_3 and about 70×10^6 V/cm in the case of Si_3N_4 , and
thus they are not suited for low-voltage luminescence.

15 Recently, proposals have been made on use of a
thin film mainly composed of $PbTiO_3$, $Pb(Ti_{1-x}Zr_x)O_3$ or
like substance having a high dielectric constant as
dielectric layer in an electroluminescent element. These
substances are high in ϵ_1 which is over 150, but they are
20 low in E_{ib} which is on the order of 5×10^5 V/cm, so that
when using these substances, it is required to greatly
increase the film thickness in comparison with the
conventional dielectric materials. For guaranteeing the
reliability of the element produced, it is required that
25 the dielectric film has a thickness greater than $15,000 \text{ \AA}$,
for $6,000 \text{ \AA}$ in thickness of ZnS film. Generally, in case
of using said substances, the grains in the film tend to
grow to cause clouding of the film because of large

1 film thickness and high substrate temperature at the time
of formation of the film. In an X-Y matrix display using
such clouded film, light is emitted even from the non-
luminescent segments as the light from the other
5 segments is scattered, resulting in a degraded image
quality.

The present inventors had already proposed an
EL element using a dielectric film chiefly composed of
SrTiO₃, which dielectric film is high in both E_{ib} and
10 the product of E_{ib} and ϵ_i , proof against clouding and
suited for low-voltage drive. For instance, there had been
obtained an SrTiO₃ dielectric film in which $\epsilon_i = 140$ and
 $E_{ib} = 1.5$ MV/cm, the product thereof being greater than
that of a BaTiO₃ film ($10 \leq \epsilon_i \leq 40$, E_{ib} up to 2 MV/cm).
15 Reduction of driving voltage is desirable for the better-
ment of reliability and production cost of the drive
circuits, but no enough technical breakthrough has been
attained in this regard. In order to increase the lumi-
nance of the phosphor layer, this layer is subjected to a
20 heat treatment after formation of the film, but in case
a dielectric layer is present beneath said phosphor layer,
the dielectric layer also undergoes the heat treatment.
Consequently, if the dielectric layer thickness is
greater than about 0.5 μ m, certain fault is found to take
25 place in the dielectric film, affecting the breakdown
strength of the element. Also, the mode of dielectric
breakdown tends to become propagating and is unable to
self-heal.

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1 The present invention is intended to obtain a
dielectric film which is better suited for low-voltage
drive and also has higher reliability than said SrTiO_3
dielectric film. It is especially envisaged in this
5 invention to obtain a dielectric film of the type whose
dielectric breakdown, if any, is restricted to self
heal, keeping free of propagating breakdown which can be
a fatal defect for an EL element.

BRIEF DESCRIPTION OF THE DRAWING

10 The drawing is a schematic sectional view of a
thin-film electroluminescent element in an embodiment of
this invention.

 In the drawing, numeral 1 designates a glass
substrate, 2 a transparent electrode, 3 a dielectric film,
15 4 a ZnS-Mn phosphor film, 5 a Ta_2O_5 film, 6 a PbNb_2O_6
film, and 7 an Al electrode.

BEST MODE FOR CARRYING OUT THE INVENTION

 The present invention provides a thin-film
electroluminescent element comprising a filmy phosphor
20 layer, a filmy dielectric layer provided on at least one
side of said phosphor layer, and two electrode layers at
least one of which is pervious to light, said electrode
layers being so arranged as to apply a voltage to said
phosphor and dielectric layers, wherein said dielectric
25 layer is essentially of a composition represented by the
formula: $x(\text{Ti}_{1-y}\text{A}_y\text{O}_2) - (1-x)(\text{Ba}_{1-z}\text{B}_z\text{O})$ wherein

1. $0.4 \leq x \leq 0.8$, $0 < y < 1$, $0 \leq z < 1$, A is at least one element selected from Zr, Hf and Sn, and B is at least one element selected from Mg and Ca.

~~The present invention features a novel composition of dielectric film used in the conventional thin-film luminescent elements. According to the present invention, a dielectric film having ϵ_i above 50 and E_{ib} of 3×10^6 V/cm could be obtained by substituting the position of Ti in a TiO_2 -BaO system with Zr, Hf or Sn and further substituting the position of Ba with Ca or Mg as described above. The film was formed by magnetron RF sputtering method used the sintered ceramic targets prepared for the respective compositions. The result of chemical analysis of the formed film showed the substantial agreement of its composition with that of the target.~~

The dielectric film of said composition and structure has the excellent properties for use in an EL element in comparison with the conventional dielectric films. For instance, in the case of a $BaO-TiO_2-SnO_2$ system, the produced film shows higher ϵ_i and E_{ib} than the conventional $BaTiO_3$ or $SrTiO_3$ film, and accordingly the value of $\epsilon_i \times E_{ib}$ is greater than those in said conventional films. Further, the film according to this invention shows no trace of clouding due to the growth of grains and is transparent, so that when it is used as the dielectric layer in an EL element, there can be obtained an EL element with excellent image quality.

1 It was also found that the substitution of Ti with Zr or
Hf can provide as high ϵ_1 or E_{1b} as in the case of sub-
stitution with Sn and enables obtainment of a character-
istic heat-resistant dielectric film. Cracking of the
5 film in the process of heat treatment leads to a reduction
of reliability of the produced EL element because such
cracking could cause disconnection of the matrix electrode
though such is very rare. Therefore, use of a multiple-
component dielectric film shown here enables the high-
10 yield production of high-reliability EL elements free
of cracks in the dielectric layer.

The present invention will be further described
below by way of the embodiments thereof with reference
to the accompanying drawing.

15 As illustrated in the drawing, on a glass
substrate 1 provided with an ITO transparent electrode
2, a dielectric film 3 having a composition of
 $x(\text{Ti}_{0.8}\text{Sn}_{0.2}\text{O}_2) - (1-x)\text{BaO}$ was deposited to a thick-
ness of 5,000 Å by magnetron RF sputtering. The sput-
20 tering of said composition was made by changing the value
of x: 0.4, 0.5, 0.6, 0.7 and 0.8. A mixed gas of O_2
and Ar (partial pressure of O_2 : 25%) was used as sputter-
ing gas, the gas pressure during sputtering being 0.8 Pa.
Used as target was a ceramic plate prepared by mixing
25 ingredient powders in said composition and sintering the
mixture at 1,400°C. The substrate temperature was 400°C.
The produced films with the respective compositions
(differing only in the value of x in the above-shown

1 composition) were all transparent and showed no cloudiness.

At the point where the dielectric film 3 was formed, the values of ϵ_1 and E_{ib} of the film of each composition were

checked. Then ZnS and Mn were simultaneously deposited

5 on the dielectric film by electron-beam deposition to form a ZnS-Mn phosphor layer 4 with a thickness of 5,000 Å, and this layer was subjected to a heat treatment in vacuo

at 600°C for one hour. For protection of said ZnS-Mn

layer, a 400 Å thick Ta₂O₅ film 5 was further formed on

10 said ZnS-Mn layer by electron-beam deposition. On said

Ta₂O₅ film 5 was additionally deposited a PbNb₂O₆ film 6

to a thickness of 1,000 Å by magnetron RF sputtering. An

Ar mixed gas containing 25% of O₂ was used as sputtering

gas. The sputtering gas pressure was 3 Pa. A ceramic of

15 PbNb₂O₆ was used as target and the substrate temperature

was controlled to 380°C. Finally, a 1,000 Å thick Al

film 7 was formed as top electrode by electric resistance

heating deposition to complete an EL element.

~~Each of the thus formed EL elements was driven~~

20 by an AC pulse with a repetitive frequency of 5 kHz to determine the voltage-luminance characteristic. Table 1 shows the electrical properties and luminous characteristics of the elements with the respective dielectric compositions (differing in value of x).

Table 1

No.	x	ϵ_i	E_{ib} (V/cm)	$\epsilon_i \times E_{ib}$ (V/cm)	Lumi- nance (Cd/m ²) / applied voltage (V)
1	0.4	60	3.0×10^6	180×10^6	3500 / 120
2	0.5	70	3.0×10^6	210×10^6	3500 / 110
3	0.6	55	3.2×10^6	176×10^6	3500 / 125
4	0.7	40	3.5×10^6	140×10^6	3450 / 135
5	0.8	35	3.5×10^6	112×10^6	3400 / 140

1 The voltage at which the saturation brightness
of 3,400 to 3,500 Cd/m² is reached is given in the table
as a measure of luminous characteristics. As seen from
the table, the dielectric constant is maximized and also
5 the value of $\epsilon_i \times E_{ib}$ becomes largest when x is 0.5.
What is especially noteworthy in this system is that the
dielectric breakdown field strength E_{ib} is above 3×10^6 V/cm, which is far greater than that in the case
of SrTiO₃, and that the mode of dielectric breakdown is
10 self-healing type. Also, some of the obtained elements
showed a dielectric constant above 100 when the heat
treatment after deposition was conducted at 600°C for
one hour. From the above-shown dependency of ϵ_i and
 E_{ib} on the compositional change (in x), it was found
15 that the produced films are far higher in E_{ib} than that
of SrTiO₃ and has a substantially same figure of merit as
that of SrTiO₃ when x is between 0.4 and 0.8. Being
high in E_{ib} is an essential factor for improving the

1 reliability of the thin-film electroluminescent element.

As regards the luminous characteristics, the voltage that provides the saturation brightness of 3,400-3,500

Cd/m^2 is minimized (110 V) when $x = 0.5$, indicating low-

5 voltage drivability of the element. Also, said voltage is

below 140 V even when x is in the range of 0.4 to 0.8, and

thus low-voltage drive is possible.

Considering the above-shown results synthetical-

ly, it is learned that by using a composition represented

10 by the formula: $x(\text{Ti}_{0.8}\text{Sn}_{0.2}\text{O}_2) - (1-x)\text{BaO}$, with x in the

formula being defined as $0.4 \leq x \leq 0.8$, it is possible to

obtain a film more excellent than the conventional SrTiO_3

or BaTiO_3 film as a dielectric film for a low-voltage

drive type EL element.

15 We will now describe the case where the amount

of partial substitution of Ti with Sn is further changed

in said $x(\text{Ti}_{0.8}\text{Sn}_{0.2}\text{O}_2) - (1-x)\text{BaO}$ system by defining x to

0.5 at which the most excellent film properties are

obtained. The amount of substitution with Sn was varied

20 from 0 to 0.4. The method of evaluation of dielectric

film, the construction and preparing conditions of the

element and the conditions for determination of luminous

characteristics are the same as in the case of said

$\text{Ti}_{0.8}\text{Sn}_{0.2}\text{O}_2 - \text{BaO}$ system. Table 2 shows the results

25 obtained when substituting Sn for the position of Ti.

In the table, there was given a new item indicating the

percentage of cracking of the dielectric film at the time

of annealing of the ZnS-Mn phosphor layer 4 formed on

- 1 the dielectric film 3 (the percentage of cracking was calculated from the number of samples which were cracked in 10 pieces of samples tested). There was also given a column for qualitatively showing whether the state of
- 5 dielectric breakdown is self-healed or not by observing the mode of dielectric breakdown after determination of dielectric breakdown field strength.

Table 2

No.	y	ϵ_i	E_{ib} (V/cm)	$\epsilon_i \times E_{ib}$ (V/cm)	Parcen- tage of cracked samples (%)	Dielectric breakdown was: Self- healed (o), Not self- healed (x)
6	0	63	1.5×10^6	95×10^6	100	x
7	0.1	80	1.6×10^6	128×10^6	o	o
8	0.2	70	3.3×10^6	231×10^6	o	o
9	0.3	48	3×10^6	144×10^6	o	o
10	0.4	30	3×10^6	90×10^6	o	o

As seen from Table 2, both ϵ_i and E_{ib} tend to increase with the partial substitution of Ti with Sn.

- 10 Thus, when Ti is substituted with Sn to a degree where y is 0.3 or below, there can be obtained a greater figure of merit than that obtainable with a $0.5\text{TiO}_2 - 0.5\text{BaO}$ film. Especially, the figure of merit of $\epsilon_i \times E_{ib}$ is maximized when the substitution rate y of Sn is 0.2 or

1 thereabout. Thus, in this region of Sn substitution rate,
the high-yield production of low-voltage drive EL
element proof against cracking at the time of annealing
is possible. Also, when y (Sn substitution rate) was
5 0.1, 0.2 and 0.3, the dielectric constant of the
dielectric film after annealing was 150, 130 and 100,
respectively, indicating a further reduction of drive
voltage for EL element by the Sn substitution for Ti in
said range.

10 The effect of similar substitution for Ti with
Zr and Hf was examined in the same way as in the case of
substitution with Sn. It was found that, in this case,
the value of $\epsilon_i \times E_{ib}$ is maximized and also the film
becomes most resistant to cracking when y is 0.2 or
15 therearound as in the case of Sn. It is especially
noteworthy in the case of Zr and Hf that the range of
substitution rate (y) that provides a large figure of
merit is wide, and it was confirmed that even when y
was 0.5, the produced dielectric film could well serve
20 for a low-voltage drive EL element. For instance, in the
case of $0.5(\text{Ti}_{0.7}\text{Zr}_{0.3}\text{O}_2) - 0.5\text{BaO}$, ϵ_i was 60 and E_{ib}
was 2.5×10^6 V/cm, and further the mode of dielectric
breakdown was self-healing type. Also, in the case of
 $0.5(\text{Ti}_{0.5}\text{Zr}_{0.5}\text{O}_2) - 0.5\text{BaO}$, $\epsilon_i = 30$ and $E_{ib} = 3 \times 10^6$
25 V/cm, and in the case of $0.5(\text{Ti}_{0.6}\text{Hf}_{0.5}\text{O}_2) - 0.5\text{BaO}$,
 $\epsilon_i = 35$ and $E_{ib} = 3 \times 10^6$ V/cm.

It is needless to say that an excellent low-
voltage drive EL element can be obtained by properly

1 combining the substituting elements Sn, Zr and Hf for the position of Ti.

The results obtained from substitution for the position of Ba with Mg and Ca are shown below.

5 The method of evaluation of dielectric film, the structure and preparing conditions of the element and the luminous characteristic determining conditions were the same as in the case of said $0.5\text{Ti}_{1-y}\text{Sn}_y\text{O}_2 - 0.5\text{BaO}$ system.

10 Table 3 shows the results obtained from Mg substitution for the position of Ba.

Table 3

No.	Value of z in $0.5\text{Ti}_{0.8}\text{Sn}_{0.1}\text{O}_2 - 0.5(\text{Ba}_{1-z}\text{Mg}_z\text{O})$	ϵ_i	E_{ib} (V/cm)	$\epsilon_i \times E_{ib}$ (V/cm)	Percentage of crack- ing
11	0	80	1.6×10^6	128×10^6	○
12	0.1	75	1.8×10^6	135×10^6	○
13	0.2	70	2.0×10^6	140×10^6	○
14	0.3	65	2.5×10^6	163×10^6	○
15	0.4	50	2.8×10^6	140×10^6	○
16	0.6	20	3.0×10^6	60×10^6	○

As seen from Table 3, partial substitution of Ba with Mg produces an decreasing tendency of ϵ_i while causing an increase of E_{ib} . Thus, in the range of about 15 10 to 30% substitution for Ba with Mg, the produced film

1 is improved in figure of merit over the non-substituted
film. Also, no cracking was caused by the substitution
of Ba with Mg. However, when the Mg substitution rate
exceeds 60%, the dielectric constant is reduced to the
5 order of 20 and the figure of merit falls below the level
of 100×10^6 V/cm suited for low-voltage luminescence
(about 7 times the figure of merit provided by ZnS).
Therefore, the appropriate substitution rate of Mg for

Ba would be less than 40%. In this range, it is
10 possible to produce, in a high yield, a low-voltage drive
EL element having no risk of cracking at the time of
annealing.

The case of Ca substitution in the completely
same manner as in the case of Mg described above was
15 also examined. In this case, there was observed the same
tendency concerning ϵ_i and E_{ib} as in the case of Mg, and
also no crack was seen in the produced film. The optimal
range of Ca substitution rate was determined to be less
than 30%; any greater substitution rate drops the figure
20 of merit below 100×10^6 V/cm and also makes the film
prone to clouding. In the film with a composition of
 $0.5(\text{Ti}_{0.9}\text{Sn}_{0.1}\text{O}_2) - 0.5(\text{Ba}_{0.7}\text{Ca}_{0.3}\text{O})$, $\epsilon_i = 60$, $E_{ib} =$
 2.3×10^6 V/cm, and $\epsilon_i \times E_{ib} = 138 \times 10^6$ V/cm. It was
also found that the produced dielectric film comes to
25 show a self-healing type dielectric breakdown when the
position of Ti is substituted with Sn by a factor of
about 0.1 to 0.3.

As described above, by use of the compositions

1 according to this invention, there can be obtained a dielectric film which is proof against cracking and is characteristically high in ϵ_i and E_{ib} and hence also high in figure of merit. Further, when Ti in the composition is substituted with Sn, Zr or Hf, dielectric breakdown of the film is rendered self-healing type.

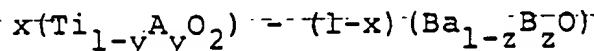
It is of course possible to adopt a four-component system incorporating said substitutions within the specified range of substitution rate for the purpose of combining the advantages of the respective substituting elements (Sn, Zr or Hf for Ti, and Mg or Ca for Ba) in the basis composition of TiO_2 -BaO.

INDUSTRIAL APPLICABILITY

As described above, according to the present invention, the filmy dielectric layer of a thin-film electroluminescent element is composed of a dielectric having a composition of $x(Ti_{1-y}A_yO_2) - (1-x)BaO$ which is high in figure of merit and resistant to cracking and whose dielectric breakdown tends to self-heal, so that it is possible to obtain a low-voltage drive type electroluminescent element with high image quality and reliability in a high yield. This is of great industrial value from the aspects of improvement of reliability and production cost of drive circuits.

WHAT IS CLAIMED IS:

1. A thin-film electroluminescent element comprising a filmy phosphor layer, a filmy dielectric layer provided on at least one side of said phosphor layer, and two electrode layers at least one of which is pervious to light, said electrode layers being so arranged as to apply a voltage to said phosphor and dielectric layers, wherein the essential composition of said dielectric layer is expressed by the following formula:



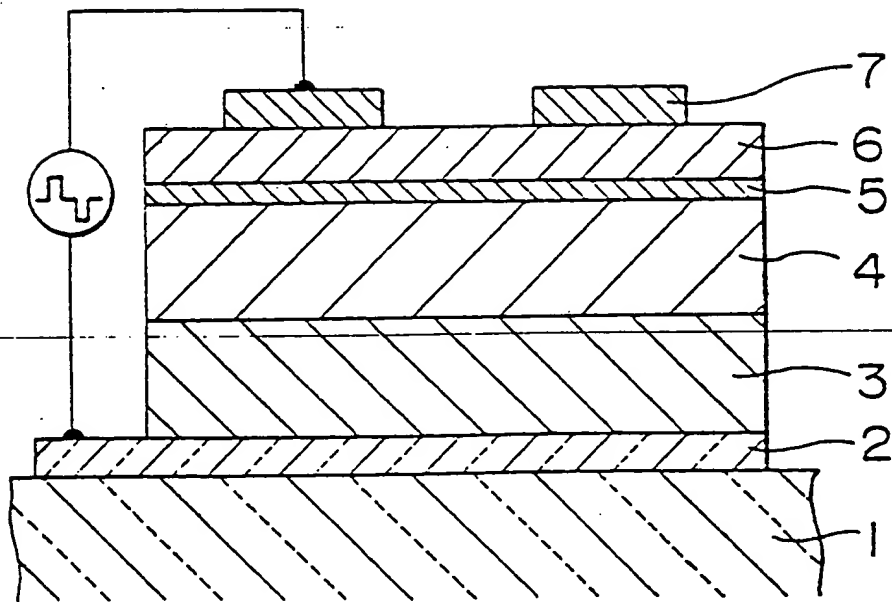
wherein x, y and z are the numbers defined as: $0.4 \leq x \leq 0.8$, $0 < y < 1$, and $0 \leq z < 1$, and A is at least one element selected from Zr, Hf and Sn, and B is at least one element selected from Mg and Ca.

2. A thin-film electroluminescent element according to Claim 1, wherein in the compositional formula of the essential components of the dielectric layer, A is Zr or Hf and y is a range defined as: $y \leq 0.5$.

3. A thin-film electroluminescent element according to Claim 1, wherein in the compositional formula of the essential components of the dielectric layer, A is Sn and y is a range defined as: $y \leq 0.3$.

4. A thin-film electroluminescent element according to Claim 1, wherein in the compositional formula of the essential components of the dielectric layer, B is Mg and z is a range defined as: $z \leq 0.4$.

5. A thin-film electroluminescent element according to Claim 1, wherein in the compositional formula of the essential components of the dielectric layer, B is Ca and z is a range defined as: $z \leq 0.3$.





European Patent
Office

EUROPEAN SEARCH REPORT

0145470

Application number

EP 84 30 8539

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
Y	DE-A-2 737 080 (MURATA) * Claims *	1	H 05 B 33/22 H 01 B 3/12
Y	FR-A-2 439 463 (TDK) * Claims 1-10 *	1	
Y	FR-A-2 376 500 (SIEMENS) * Claims 1-6 *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
			H 05 B H 01 B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 09-03-1987	Examiner DROUOT M.C.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published in, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	